

Review

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Review

Enhancing Performance and Reducing Injury Risk: Integrating Resistance and Flexibility Training for Hamstring Injury Prevention in Rural-Based Soccer Players– A Narrative Review

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Abstract: Hamstring injuries present a notable challenge to the performance and durability of soccer athletes, particularly those situated in rural areas where access to specialized training facilities may be scarce. This literature review delves into the amalgamation of resistance and flexibility training as a holistic strategy for averting hamstring injuries among rural-based soccer athletes. Utilizing existing scholarly works, this review underscores the significance of resistance training in enhancing hamstring strength, power, and stamina, while flexibility training augments muscle pliability and range of motion, thus diminishing the likelihood of injuries. Furthermore, it scrutinizes a range of resistance and flexibility routines customized to meet the specific requirements of soccer and the limitations of rural settings. Through the amalgamation of evidence-based methodologies, this review puts forth the mechanisms of injury and pragmatic suggestions for coaches, trainers, and athletes to implement efficient injury prevention protocols. Highlighting the collaborative advantages of resistance and flexibility training, this methodology strives to enhance performance and shield against hamstring injuries in rural-based soccer athletes.

Keywords: hamstring injury prevention; strength training; range of motion training; soccer; rural areas; sports performance enhancement

Introduction

Sports are known to play a crucial role in making a substantial contribution to one's physical well-being. nonetheless, they also expose athletes to specific risks [1]. Interestingly, epidemiological studies have noted that the risk of injury is approximately 1.5 to 2.0 times greater in individuals who often participate in various sports [2]. Sports such as basketball, rugby, and soccer, have higher rates of incidences of lower extremity injuries (LEI) which are commonly sustained during training and competitions [3]. On the other hand, sports injuries have placed a significant economic crisis on athletes and sports groups worldwide with an evident negative impact on low-middle income countries (LMICs) [4] than high-income countries (HICs) [5].

Recent research conducted in Australia showed that the direct cost of sport-related injuries over seven years is approximately \$265 million which contradicts the South African reports that indicate about 5% more costs [6]. Lower extremity injuries account for more than 60% of the total burden of injuries, most of these injuries being ankle and knee injuries [3]. Athletes from low settings often quit the sport due to unrehabilitated injuries that reoccur during training and competition [7–9], and as such, a sports injury as seen in soccer can directly result in an athlete stopping training or competing which negatively affect the athlete's sports career [8]. Apart from soccer, hamstring injuries are mostly common in sports that involve motor skills being performed at high intensities such as running, jumping, and sudden changes in direction [10]. Moreover, these injuries can range from

mild strains to severe tears, leading to significant pain, discomfort, and time away from sport which further significantly impact an athlete's performance and overall well-being [9,10].

Hamstring injuries can occur due to various mechanisms, including stretch-related movements in closed kinetic chain, sprinting, and mixed-type actions [11]. These injuries frequently involve forced hip hyperflexion combined with knee extension and can result in severe proximal hamstring tendon avulsions [9–11]. In soccer, most hamstring injuries occur during high-speed movements, such as change of direction, kicking, and running [11]. Moreover, Hamstring injuries can be influenced by factors such as the morphological and connected pattern diversity of the hamstrings, mechanical properties, stress-strain performance, and motor function insufficiency [11].

The primary muscles involved in hamstring injuries are the three muscles that make up the hamstring group: the biceps femoris, semitendinosus, and semimembranosus [12]. These muscles originate from the ischial tuberosity (sit bones) of the pelvis and are inserted onto various points on the tibia and fibula bones of the lower leg [13]. The bicep femoris has two heads; the long head originates from the ischial tuberosity (sit bone) of the pelvis, while the short head originates from the back of the femur (thigh bone). Both heads of the biceps femoris are inserted into the fibula head (a bone in the lower leg) [13]. In this regard, when these muscles contract forcefully or are overstretched beyond their capacity, they can suffer from strains or tears [13,14]. Depending on the severity of the injury, the damage may range from mild strains to partial or complete tears of the muscle fibers [14]. The most affected muscle is the proximal biceps femoris [11–14]. It is worth noting that hamstring injuries in soccer often occur due to a combination of rapid, forceful movements, insufficient warm-up, fatigue, and biomechanical factors [14]. Interestingly, studies reveal that preventive measures such as proper warm-up, stretching, strength training, and conditioning can help reduce the risk of hamstring injuries in soccer players [13].

Nevertheless, soccer is one of the sports that requires high-intensity aerobic capacity in an athlete, and often players average 10km of running per game [15]. Interestingly, about 8-18% of the distance covered is mostly performed at high speed [16]. The sport is mostly directed by the efforts of powerful exertion during the match which tend to determine the outcome of the results in a game [17]. In this regard, this makes the sport highly prone to risks of musculoskeletal injuries such as ankle sprains, shin splints, knee injuries, and musculotendinous injuries (i.e., hamstring injuries). Moreover, research has indicated that soccer players are mostly predisposed to hamstring injuries particularly if the individual had no previous exposure to muscle stabilization and resistance training [18].

Consequently, substantial evidence has indicated that inadequate strength and conditioning along with flexibility in the hamstring muscles can increase the likelihood of injuries. Further, it decreases sports participation which highlights the importance of targeted training programs for injury prevention, particularly in soccer [18]. Previous research has shown that the development of an effective muscular strength and flexibility training protocol is vital in soccer to prevent injury occurrence and recurrence of hamstring injuries [18]. According to Gabbett. [19], there was a positive correlation between recovery techniques and training load management when it comes to preventing or lowering the risk of injury.

Moreover, Yue et al. [20], discovered that some athletes' socioeconomic status differences resulted in a reduced ability to access medical centers and certified athletic trainers for prompt diagnosis and treatment. This could be the primary cause of hamstring injuries, which are frequently reported in soccer players who play in rural areas. Furthermore, Gabbe. [21] discovered that these players' and coaches' access to information on these injuries was restricted due to these inadequate resources. Although immense research around the concepts of designing injury prevention programs for hamstring strains exists, there's still limited evidence that suggests that these interventions are useful among rural-based soccer players in rural-based universities, particularly due to their lack of access to better healthcare, rehabilitation centers, training facilities/resources, and professionally certified coaches. Therefore, the tailoring of a scientifically structured hamstring injury prevention program which mainly focuses on the effects of short-term interventions that

focus on resistance and flexibility training to enhance performance and reduce hamstring injury risk among rural-based soccer players is still warranted.

Occurrences of Hamstring Injuries in Sport: Soccer

Hamstring injuries are common among rural-based soccer players and are known to be a significant cause of time lost from training and competition [22]. The prevention and management of these injuries are crucial for athletes to perform at their best [19]. One potential approach to reducing hamstring injuries is through a targeted intervention training program focusing on flexibility and resistance training [23].

Hamstring injuries are the result of a convergence of physiological elements. The myotendinous junction (MTJ), the point where the muscle meets the tendon, is frequently impacted in instances of hamstring strain injuries [13]. The healing capacity of skeletal muscle is pronounced, but the connective tissue associated with the muscle, such as the tendon/aponeurosis, has a long repair period and incomplete repair [19]. Differences in tissue healing and regeneration between muscle and connective tissue may contribute to the high recurrence rate of hamstring injuries [21,22]. Fatigue can also lead to alterations in neuromuscular coordination patterns, potentially increasing the risk of hamstring injury [13]. Anatomical variations in the hamstring muscles, such as muscle bellies, fiber types, and tendon length, may also contribute to the risk of muscle strain [24]. Overall, a comprehensive understanding of the physiological aspects of hamstring injury is crucial for developing effective prevention and rehabilitation.

Various factors, such as time to peak torque (TPT) and hamstring flexibility, are influential in determining the likelihood of sustaining a hamstring injury [13]. In addition, non-modifiable risk factors, encompassing anatomical and physiological discrepancies in the hamstrings, also contribute to adjusting the risk of injury [25]. The hamstring muscles' architecture and fiber length, including the biceps femoris long head (BF-L) and semimembranosus (SM), are implicated in the susceptibility to muscle strain [25]. Following the literature, a study conducted by Kumazaki et al. [24] indicated that the muscle strain risk was most pronounced in the BF-L muscle, followed by the SM muscle. Electromyography (EMG) readings at a knee angle of 0° were significantly higher compared to other angles, with similar levels observed in BF-L, SM, and ST muscles, but notably lower in BF-S [24]. In this regard, BF-L and SM muscles are at the greatest risk of muscle strain, which is exacerbated by knee joint extension. Nonetheless, the precise mechanism of hamstring injury during high-intensity running remains inadequately understood, and the impact of fatigue on muscle activation and function necessitates further exploration [25]. In general, a blend of factors associated with muscle-tendon interaction, individual attributes, and fatigue collectively influence the incidence of hamstring injuries [18,24].

Impact of Resistance Training on Hamstring Injuries

Resistance training is one of the essential components of injury prevention for collegiate soccer players. Several studies have examined the effects of resistance training on hamstring injuries and overall athletic performance [26]. In accordance, a meta-analysis by Opar et al. [27] evaluated the effectiveness of Nordic hamstring exercises such as leg curls in preventing hamstring injuries in soccer players. Their findings revealed that athletes who incorporated Nordic hamstring exercises into their training regimen had a lower risk of hamstring injuries compared to those who did not perform these exercises [27]. Along those lines, strength training is also crucial for improving muscular strength and power, which aids in the reduction of exposure to sustaining hamstring injuries [28]. A study by Askling et al. [29] investigated the effects of short-term strength training on hamstring injuries and recovery. Concurrently, a study by Ertelt et al. [28] examined the impact of a 4-week strength training program on hamstring injuries in female soccer players. Both studies reported similar findings that showed that athletes who participated in short-term strength training programs had improved muscle strength and reduced likelihood of hamstring injuries [28]. Furthermore, in agreement with the previous study, research has shown that incorporating eccentric strength training exercises, such as the Nordic hamstring curl, into the rehabilitation program assists athletes recover

faster and reduces the risk of injury recurrence [30]. This study underscores the importance of including targeted strength training exercises in the rehabilitation phase for rural-based soccer players with hamstring injuries.

Impact of Flexibility Training on Hamstring Injuries

Literature has revealed that flexibility training plays a crucial role in preventing hamstring injuries by improving the range of motion (ROM) of the muscles and reducing the risk of strains and tears [31]. Several studies have investigated the impact of flexibility training on hamstring injuries among rural-based soccer players [31–33]. In this vein, recent research utilising a 4-week intervention among rural-based soccer players reported significant improvements in performance markers (i.e., agility) that led to a positive decrease in the incidence of hamstring injuries [22]. Moreover, the study provided guidelines that emanated from a holistic approach with an emphasis on incorporating specific stretches and mobility exercises to enhance flexibility in the hamstrings. In this regard, athletes with adequate eccentric hamstring strength and flexibility are less likely to experience hamstring strains during sports activities.

Importance of Performance Metrics (Balance and Proprioception, Sprint Speed) in Soccer

Balance and proprioception are key components of neuromuscular control, helping athletes maintain stability and control during dynamic movements [34]. In contrast, poor balance and proprioception can increase the risk of injury by compromising joint alignment and muscle coordination [34]. A study by Silvers-Granelli et al. [35] assessed the effects of a short-term intervention composed of 4-week balance and proprioception training exercises on hamstring injuries in collegiate soccer players. The results showed a significant decrease in injury rates among players who participated in the program, highlighting the importance of neuromuscular training in enhancing joint stability and reducing the risk of hamstring strains [35].

Among balance and proprioception, another critical performance metric component in soccer is sprint speed which directly influences a player's ability to outrun their opponents, create scoring opportunities, and track back defensively [34–36]. Along those lines, research conducted by Haugen et al. [36] revealed that sprint speed is positively correlated with success in soccer, with faster players demonstrating a higher likelihood of scoring goals and assisting teammates. In agreement with the previous study, recent research has emphasized the importance of sprint speed in elite soccer, highlighting its association with high-intensity actions during matches [37–39]. On that note, enhancing sprint speed through targeted training programs can significantly impact players' effectiveness in the field.

Conclusions

The issue of hamstring injuries presents a notable concern within the collegiate soccer community, often resulting in diminished performance, prolonged recovery periods, and potential long-term implications. Despite the implementation of various preventive measures in training regimens, hamstring injuries persist at a high frequency, indicating a deficiency in current treatment and rehabilitation approaches. Dejectedly, the South African healthcare system remains segregated with various preventative and treatment strategies being available mostly unilaterally among private organisations which usually favors urban soccer players and deprives timely diagnosis and treatment to rural-based soccer players ultimately affecting their sports performances and careers. Therefore, there is a paucity of evidence that shows the effectiveness of clinical significance of hamstring injury prevention protocols among rural-based soccer players dwelling in rural areas. Further, a research gap exists in the efficacy of incorporating resistance and flexibility training protocols customized for rural-based collegiate soccer players. Through an analysis of the effects of these interventions on hamstring strength, flexibility, and performance indicators, there will be advancement of more holistic and precise strategies for preventing hamstring injuries in rural-based soccer players both in rural and urban areas. Moreover, this will provide healthcare professionals

with tailored scientifically structured programs to specifically address the pandemic issue of hamstring injuries in soccer increases sports career success and reduce sport exit levels predominantly in rural-based collegiate soccer players.

References

1. Katzmarzyk, P.T. et al. (2021). Physical inactivity and non-communicable disease burden in low-income, middle-income and high-income countries. *British journal of sports medicine*, 56(2), 101-106. doi:10.1136/bjsports-2020-103640
2. Bayer, M. L., & Järvinen, T. A. (2020). Basic muscle physiology in relation to hamstring injury and repair. *Prevention and Rehabilitation of Hamstring Injuries*, 31-63. doi:10.1007/978-3-030-31638-9_2
3. Bourne, M., Schuermans, J., Witvrouw, E. et al. (2020). Neuromuscular factors related to hamstring muscle function, performance and injury. *Prevention and rehabilitation of hamstring injuries*, 117-143. doi:10.1007/978-3-030-31638-9_5
4. de Oliveira, N. T., Medeiros, T. M., Vianna, K. B. et al. (2020). A four-week training program with the Nordic hamstring exercise during preseason increases eccentric strength of male soccer players. *International journal of sport physical therapy*. 15(4), 571-578.
5. Bien, D. P. (2011). Rationale and implementation of anterior cruciate ligament injury prevention warm-up programs in female athletes. *The journal of strength & conditioning research*, 25(1), 271-285
6. Ross, A. G., McKay, M. J., Pappas, E. et al. (2022). Direct and indirect costs associated with injury in sub-elite football in Australia: A population study using 3 years of Sport Insurance Records. *Journal of science and medicine in sport*, 25(9), 743-749. doi:10.1016/j.jsams.2022.06.005
7. Orchard, J. W., Seward, H., & Orchard, J. J. (2013). Results of 2 decades of injury surveillance and public release of data in the Australian Football League. *The American journal of sports medicine*, 41(4), 734-741. doi:10.1177/0363546513476270
8. Reiman, M. P., & Lorenz, D. (2011). Intergration of strength and conditioning principles into a rehabilitation program. *International journal of sport physical therapy*, 6(3), 241-253.
9. Laux, P., Krumm, B., Diers, M., & Flor, H. (2015). Recovery–stress balance and injury risk in professional football players: A prospective study. *Journal of sports sciences*, 33(20), 2140-2148. doi:10.1080/02640414.2015.1064538
10. Ranasinghe, P. D., Pokhrel, S., & Anokye, N. K. (2021). Economics of physical activity in low-income and middle-income countries: A systematic review. *BMJ Open*, 11(1). doi:10.1136/bmjopen-2020-037784
11. Allahabadi, S., Salazar, L.M., Obioha, O.A., et al. (2024). Hamstring injuries: a current concepts review: evaluation, nonoperative treatment, and surgical decision making. *The American Journal of Sports Medicine*, 52(3), 832-844.
12. Danielsson, A., Horvath, A., Senorski, C. et al. (2020). The mechanism of hamstring injuries—a systematic review. *BMC musculoskeletal disorders*, 21, 1-21. doi:10.1186/S12891-020-03658-8
13. Hauret, K. G., Bedno, S., Loring, K. et al. (2015). Epidemiology of exercise-and sports-related injuries in a population of young, physically active adults. *The American journal of sports medicine*, 43(11), 2645-2653. doi:10.1177/0363546515601990
14. Beynon, B. D., Vacek, P. M., Newell, M. K. et al. (2014). The effects of level of competition, sport, and sex on the incidence of first-time noncontact Anterior Cruciate Ligament Injury. *The American journal of sports medicine*, 42(8), 1806-1812. doi:10.1177/0363546514540862
15. Petersen, J., & Hölmich, P. (2005). Evidence based prevention of hamstring injuries in sport. *British journal of sports medicine*, 39(6), 319-323.
16. Danielsson, A., Horvath, A., Senorski, C. et al. (2020). The mechanism of hamstring injuries—a systematic review. *BMC musculoskeletal disorders*, 21, 1-21. doi:10.1186/S12891-020-03658-8
17. Huygaerts, S., Cos, F., Cohen, D. D. et al. (2020). Mechanisms of hamstring strain injury: interactions between fatigue, muscle activation and function. *Sports*, 8(5), 65. doi:10.3390/sports8050065
18. Wing, C., & Bishop, C. (2020). Hamstring strain injuries: Incidence, mechanisms, risk factors, and training recommendations. *Strength & Conditioning Journal*, 42(3), 40-57. doi:10.1519/SSC.0000000000000538
19. Gabbe, B.J. (2003). How valid is a self reported 12 month sports injury history?. *British journal of sports medicine*, 37(6), 545-547. doi:10.1136/bjism.37.6.545
20. Yue JK, Upadhyayula PS, Avalos, L. N. et al. (2020). Concussion and mild-traumatic brain injury in rural settings: Epidemiology and specific health care considerations. *Journal of neurosciences in rural practice*, 11(01), 23-33. doi:10.1055/s-0039-3402581
21. Gabbett, T. J. (2016). The training-injury prevention paradox: should athletes be training smarter and harder?. *British journal of sports medicine*, 50(5), 273-280.

22. Ekblom, B. (2012). Applied Physiology of Soccer. *Sports medicine*, 3(1), 50-60. doi: 10.2165/00007256-198603010-00005
23. Bourne, M. N., Timmins, R. G., Opar, D. A. et al. (2018). An evidence-based framework for strengthening exercises to prevent hamstring injury. *Sports medicine*, 48, 251-267.
24. Kumazaki, T., Ehara, Y., & Sakai, T. (2012). Anatomy and physiology of hamstring injury. *International journal of sports medicine*, 33(12), 950-954. doi:10.1055/S-0032-1311593
25. Tumilty, D. (1993). Physiological characteristics of elite soccer players. *Sports medicine*, 16, 80-96. doi:10.2165/00007256-199316020-00002
26. Arnason, A., Andersen, T. E., Holme, I. et al. (2008). Prevention of hamstring strains in elite soccer: an intervention study. *Scandinavian journal of medicine & science in sport*, 18(1), 40-48. doi:10.1111/j.1600-0838.2006.00634.x
27. Opar, D. A., Williams, M. D., Timmins, R. G. et al. (2015). Eccentric hamstring strength and hamstring injury risk in Australian footballers. *Medicine & science in sports & exercise*, 47(4), 857-865. doi:10.1249/mss.0000000000000465
28. Ertelt, T., Solomonovs, I. and Gronwald, T. (2018). Enhancement of force patterns classification based on Gaussian distributions. *Journal of Biomechanics*, 67, 144-149. doi:10.1016/j.jbiomech.2017.12.006
29. Cross, K. M., Saliba, S. A., Conaway, M. et al. (2015). Days to return to participation after a hamstrings strain among American collegiate soccer players. *Journal of athletic training*, 50(7), 733-741. doi:10.4085/1052-6050-50.2.12
30. Taimela, S., Kujala, U. M., & Osterman, K. (1990). Intrinsic risk factors and athletic injuries. *Sports medicine*, 9(4), 205-215. doi:10.2165/00007256-199009040-00002
31. Williams, J. G., Gard, H. I., Gregory, J. M. et al. (2019). The effects of cupping on hamstring flexibility in college soccer players. *Journal of sport rehabilitation*, 28(4), 350-353.
32. Clark, R., Bryant, A., Culgan, J. P. et al. (2005). The effects of eccentric hamstring strength training on dynamic jumping performance and isokinetic strength parameters: a pilot study on the implications for the prevention of hamstring injuries. *Physical therapy in sport*, 6(2), 67-73.
33. Murtagh, C. F., Nulty, C., Vanrenterghem, J. et al. (2018). The neuromuscular determinants of unilateral jump performance in soccer players are direction-specific. *International journal of sports physiology and performance*, 13(5), 604-611. doi:10.1123/ijsp.2017-0589
34. Worrell, T. W., & Perrin, D. H. (1992). Hamstring muscle injury: the influence of strength, flexibility, warm-up, and fatigue. *Journal of orthopaedic & sports physical therapy*, 16(1), 12-18.
35. Allahabadi, S., Salazar, L.M., Obioha, O.A., Fenn, T.W., Chahla, J. and Nho, S.J., 2024. Hamstring injuries: a current concepts review: evaluation, nonoperative treatment, and surgical decision making. *The American Journal of Sports Medicine*, 52(3), pp.832-844.
36. Askling, C. M., Tengvar, M., Saartok, T., & Thorstensson, A. (2007). Acute first-time hamstring strains during high-speed running: a longitudinal study including clinical and magnetic resonance imaging findings. *The American journal of sports medicine*, 35(2), 197-206. doi:10.1177/0363546506294679
37. Alonso-Fernandez, D., Docampo-Blanco, P., & Martinez-Fernandez, J. (2017). Changes in muscle architecture of biceps femoris induced by eccentric strength training with Nordic hamstring exercise. *Scandinavian journal of medicine & science in sports*, 28(1), 88-94. doi:10.1111/sms.12877
38. Zemková E, Kováčiková Z. Sport-specific training-induced adaptations in postural control and their relationship with athletic performance. *Frontiers in Human Neuroscience*. 2023, 12;16:1007804.
39. Silvers-Granelli, H. et al. (2015). Efficacy of the FIFA 11+ injury prevention program in the collegiate male soccer player. *The American journal of sports medicine*, 43(11), 2628-2637. doi:10.1177/0363546515602009